Offshore wind on the high seas: resource potential and legal implications for developing projects beyond the national jurisdiction of coastal States

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Abstract

Offshore wind projects are currently restricted to the exclusive economic zones (EEZ) of coastal States. Recent advances in offshore wind technology are raising the prospect of utilising excellent wind resources on the high seas. We identify potential resource areas which include Rockall Bank/Hatton Ridge just outside the UK EEZ in the North Atlantic. The legal framework for wind energy projects on the high seas is the United Nations Convention in the Law of the Sea where flag states play a central regulatory role. Flags of convenience might evolve and undercut environmental and safety standards. Marine spatial planning approaches could safeguard against such potential misappropriation.

Introduction and Objectives

Many excellent offshore wind resources are located beyond the world's EEZ, on the high sea. Recent advances of a maturing offshore wind energy sector make it now appear realistic that projects could be technically and commercially viable on the high seas. The goal of this research project was to, first, identify suitable locations for potential offshore wind projects on the high seas. Second, to assess the legal framework that would be applicable to offshore wind parks on the high seas.

Methods

To identify high seas areas that may have promising potential for offshore wind energy development, a spatially explicit GIS-model was developed. Central inputs were a 11 year time series of monthly average wind speeds (January 1995 to December 2005) from the Blended Sea Winds (BSW) data set of the NOAA National Center for Environmental Information (NCEI) (Zhang et al., 2006). BSW wind speed estimates were upscaled to an assumed hub height of 100 m, using the logarithmic wind profile function. Water depth information was sourced from the GEBCO_2014 data set of the General Bathymetric Chart of the Oceans (GEBCO) project (Weatherall et al., 2015). The delineation of the coastal EEZ data was determined using geospatial data from the Flanders Marine Institute Marine Regions data depository.

To estimate the technical resource capacity of the identified high seas areas, an array power density of 3 MW/km^2 was assumed. We further assumed that a suitable offshore wind energy area should have at least a size of 100 km^2 to make it commercially viable.

Potential annual electricity production at specific sites was estimated by using an empirical function to determine turbine capacity factor (CF) of a Vestas V164-8MW turbine reference turbine. Two depth levels were considered for this study. In the *shallow water* case, a maximum water depth of 50 m was allowed. This reflects the operational limit for bottom mounted turbines. In the *deep water* case the maximum water depth was 1000 m and which a scenario where floating platforms are available.

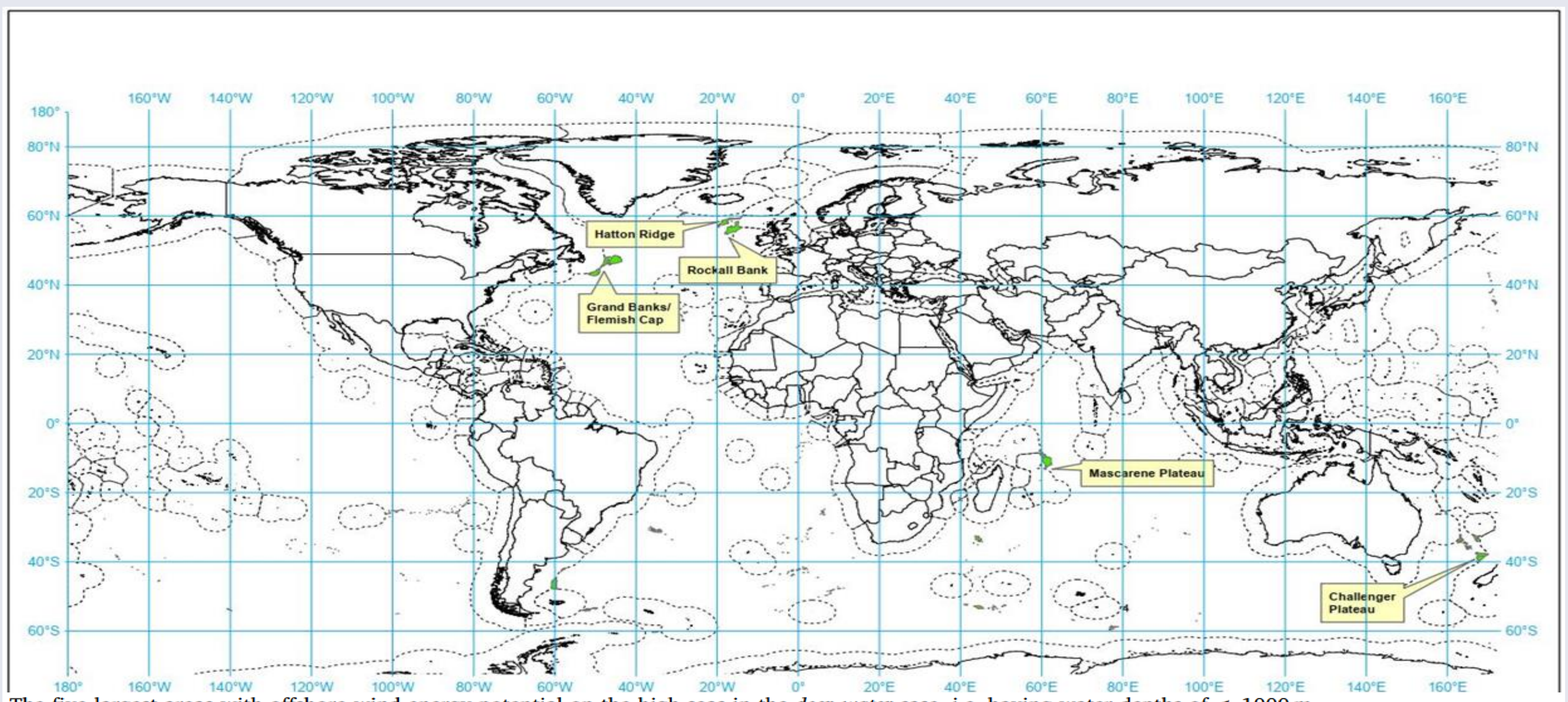
Legal Framework

Under the United Nations Convention in the Law of the Sea (UNCLOS), any offshore wind park project on the high seas will be governed by the flag State legal framework. Ideally, flag States that initiate offshore wind energy development on the high seas should already possess the experience and know-how of offshore wind projects in their territorial seas or the EEZs. One potential source of uncertainty is the phenomenon of flag of convenience, which is a situation when shipping companies register in countries with a lenient regulatory framework, thus avoiding compliance with internationally accepted safety regulations and being far from the reach of flag State authorities enforcing these rules.

In respect to cables and onshore grid connection, no State needs to ask the permission of any other State before cables can be laid on these areas. The national laws of the operator who owns or is laying the cables will apply. In laying cables, States must exercise due regard to cables and pipelines already in position (Art. 79.5 UNCLOS). In practice, cable operators and owners comply with the recommendations and rules on cable routes and cable crossing criteria adopted by the International Cable Protection Committee (UNEP and ICPC, 2009). However, cables which are laid in the territorial sea which are connected from the continental shelf or the high seas, will need to obtain the permission of the coastal State. Further, such cables shall be laid in accordance with the conditions and requirements set by the coastal State.

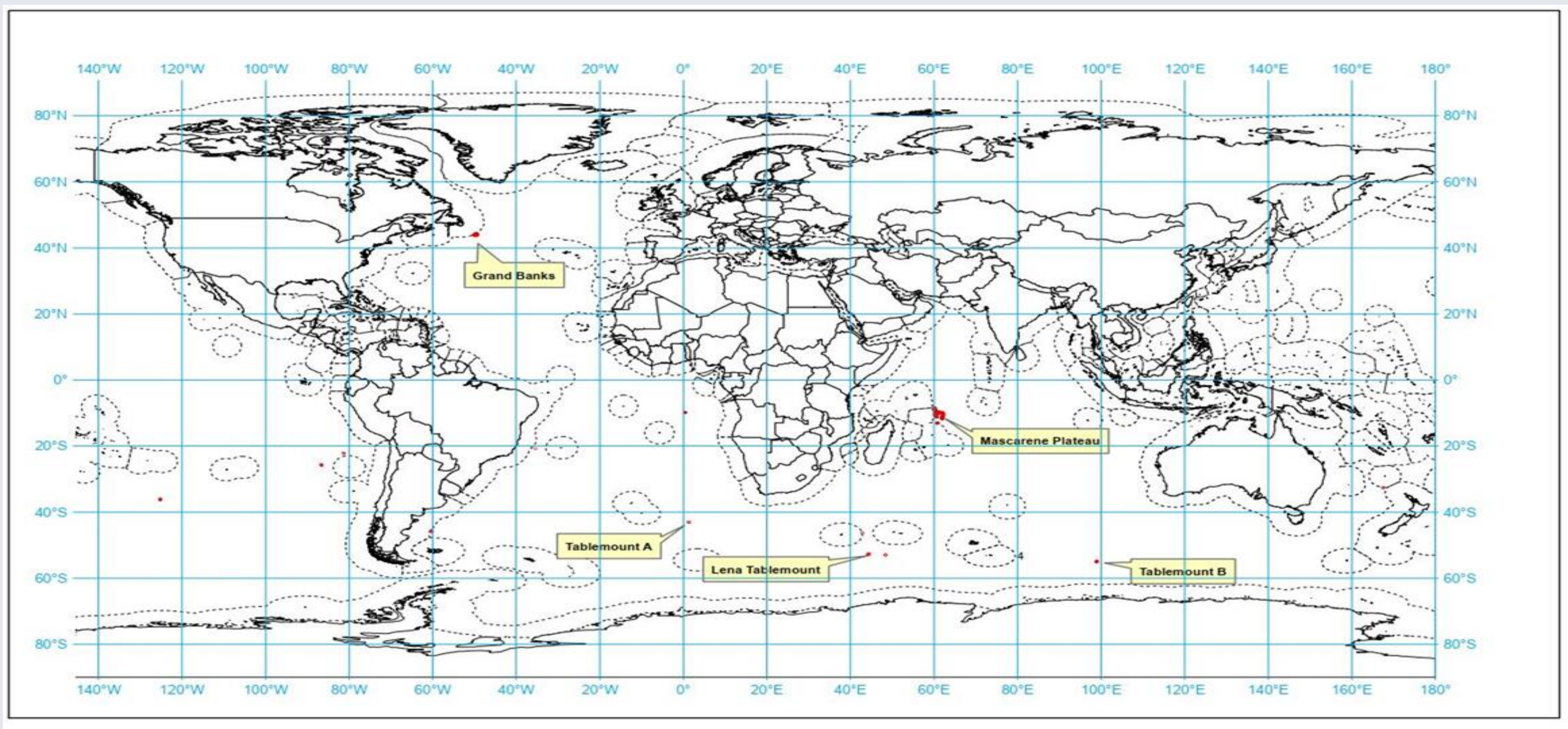
Results

Our spatially explicit global model delineated a substantial number of high seas areas with significant technical wind energy potential for both scenarios. The *shallow water* case identified overall an area of 16231 km^2 that could potentially be suitable for offshore wind development with bottom foundations. This translates to a technical capacity of 48.7 GW with an annual energy generation capacity of approximately 209 TWh. The *deep water* case identified approximately 480 000 km^2 of potential marine area. This would allow the installation of 2250 GW of floating capacity which could generate 7300 TWh of energy per year. The five largest resource areas represent the large majority of the global potential (~ 90% of the *shallow water* potential and ~ 60% of the *deep water* is aggregated in the respective five largest areas).



The five largest areas with offshore wind energy potential on the high seas in the *deep water* case, i.e. having water depths of < 1000 m.

Feature	Size (km^2)	Wind Speed at 100 m	Technical Capacity	Annual Energy Production	Extended Continental Shelf
Grand Banks/ Flemish Cap	90,413	8.9–10.7 m/s	271.2 GW	2025.3 TWh	Yes (Canada, claimed)
Mascarene Plateau	70,161	8.3–9.5 m/s	210.5 GW	928.1 TWh	Yes (joint submission of Seychelles and Mauritius, confirmed)
Rockall Bank	40,720	12 m/s	122.2 GW	799.6 TWh	Yes (claimed by Denmark/Faroe Islands, Iceland, Ireland, UK)
Challenger Plateau	35,504	9.8–10.1 m/s	106.5 GW	534.6 TWh	Yes (New Zealand, confirmed)
Hatton Ridge	21,055	12.1 m/s	63.2 GW	418.4 TWh	Yes (overlapping claims by Denmark/Faroe Islands, Island, Ireland, UK)



The five largest areas with offshore wind energy potential on the high seas in the *shallow water* case, i.e. having water depths of < 50 m.

Feature	Size (km^2)	Wind Speed at 100 m	Technical Capacity	Annual Energy Production	Extended Continental Shelf
Mascarene Plateau	10,712	8.4–9.5 m/s	32.1 GW	141.6 TWh	Yes (joint submission of Seychelles and Mauritius, confirmed)
Grand Banks	2791	8.9 m/s	8.4 GW	35.1 TWh	Yes (Canada, claimed)
Lena Tablemount	381	13.7 m/s	1.1 GW	8.6 TWh	No
Unnamed Tablemount A	228	12.5 m/s	0.68 GW	4.7 TWh	No
Unnamed Tablemount B	227	13 m/s	0.68 GW	4.9 TWh	No

Conclusions

Significant resource areas on the high seas have substantial technical offshore wind potential. Particularly the deep water scenario identifies excellent development opportunities just outside the EEZs of Canada, the UK and New Zealand. Given the rapid transition of offshore wind to a mature and cost-competitive energy industry, these areas could be of interest to energy investors in the mid-term. A central attraction for project initiators could be that they would not have to undergo lengthy licensing and consent procedures with coastal states. Under the high seas legal regime, flag states will play a central regulatory role for high seas wind energy. There is the danger that flags of convenience might evolve and unduly undercut environmental and safety standards that are in place for wind energy projects in EEZ and by this gain a financial advantage. Such abuse of high seas freedom could compromise the UNCLOS principle of 'due regard' for the rights of other states and actors on the high seas and the EEZ. Marine spatial planning approaches could safeguard against such potential misappropriation.

References

1. Elsner, P. and Suarez, S. (2019) Renewable energy from the high seas: Geo-spatial modelling of resource potential and legal implications for developing offshore wind projects beyond the national jurisdiction of coastal States. Energy Policy 128: 919-929.
2. Weatherall, P., Marks, K.M., Jakobsson, M., Schmitt, T., Tani, S., Arndt, J.E., Rovere, M., Chayes, D., Ferrini, V., Wigley, R., 2015. A new digital bathymetric model of the world's ocean. Earth Sci. 2, 331–345.
3. Zhang, H.M., Bates, J.J., Reynolds, R.W., 2006. Assessment of composite global sampling: Sea surface wind speed. Geophys. Res. Lett. 33, 1–5.